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## Management of Co-57 & Ge-68/Ga-68 sealed radioactive sources that are used for calibration of nuclear medicine systems

A variety of sealed radioactive sources, such as Co-57 and Ge-68/Ga-68, are used for the precise calibration of nuclear medicine systems. After their useful life, these sources need to be handled and kept into storage until they meet the general clearance criteria. For clearance after storage, it is necessary to determine the source activity by measurement. The only way is to evaluate the detector efficiency for specific source-detector geometry. In case of complex geometries, a common approach to perform the efficiency calibration is simulation by Monte Carlo.

The aim of this work is to determine the activity of spent sealed radioactive sources of Co-57 and Ge-68/Ga-68. Based on Monte Carlo simulation, a semi-empirical method was developed by utilizing the MCNPX code for evaluation of the 3'x3' NaI(Tl) detector efficiency for specific source-detector geometries.

More specifically, gamma-ray spectrums were taken by a NaI(Tl) detector for two types of sealed radioactive sources: 1) flood sources containing Co-57; 2) line sources containing Ge-68/Ga-68. The characteristic gamma ray peaks in the resulted spectrums by the decay of Co-57 (122 keV (85.6%), 136 keV (10.68%), 692.03 keV (0.157%)) and Ge-68/Ga-68 (1077 keV (2.93%)) [1], were analyzed with the software package SPECTRW [2]. For the specific source-detector geometries and gamma ray energies, simulations were performed with the MCNPX code for evaluation of the NaI(Tl) detector efficiencies. The MCNPX models were validated by the use of sources of the mentioned types with certified nominal activities.

Gamma-ray spectrums taken for different time intervals (7h, 2h, 15min for Co-57 and 7h, 1h, 15min for Ge-68/Ga-68) showed that, 2h measurement was adequate for the activity determination of the flood source Co-57, while 1h measurement provided adequate statistics for the activity determination of the line source Ge-68/Ga-68. The deviation from the nominal activity was 13.6% and 26.8% for Co-57 and Ge-68/Ga-68 source respectively and can be interpreted by the 15% uncertainty of the certified sources activities. The sources after meeting the clearance criterion can conservatively be kept in the interim storage additionally for four months before release from regulatory control.

These techniques proved accurate for the clearance of Co-57 and Ge-68/Ga-68 sealed radioactive sources.

### References

- [1] Richard B. Firestone, "Table of Isotopes", Eighth Edition, Wiley Interscience, 1996
- [2] Kalfas et al., Nucl. Instrum. Methods Phys. Res. Sect. A 830 (2016) 265-274

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